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KIRIRI WOMENS' UNIVERSITY OF SCIENCE AND TECHNOLOGY
UNIVERSITY EXAMINATIONS, 2024/2025 ACADEMIC YEAR
FIRST YEAR, SECOND SEMESTER EXAMINATION
FOR THE DEGREE OF BACHELOR OF SCIENCE (MATHEMATICS)

KMA 2109: COMPUTATIONAL MATHEMATICS

DATE: 10TH DECEMBER, 2024

TIME: 11:30AM-1:30PM

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE (COMPULSORY) AND ANY OTHER TWO QUESTIONS

QUESTION ONE: COMPULSORY (30 MARKS)

a) Given the following functions $Max f(x, y) = x + y$

$$\text{Subject to } \begin{cases} 2x + y \geq 0 \\ x + 3y \geq 10 \\ x, y \geq 0 \end{cases}$$

Describe the type of solution you would obtain if you solve the above problem.

(2 Marks)

b) Solve the following primal using the dual simplex method

(5 Marks)

Minimize $Z = 10x_1 + 5x_2 + 4x_3$ Subject to

$$\begin{cases} 3x_1 + 2x_2 - 3x_3 \geq 3 \\ 4x_1 + 2x_3 \geq 10 \\ x_1, x_2, x_3 \geq 0 \end{cases}$$

c) You have two types of feeds and three types of nutrients together with the costs of the said feeds as shown below.

| | NUTRIENTS | | | COST |
|------------------|-----------|----|----|------|
| FEEDS | A | B | C | |
| X | 3 | 7 | 3 | 10 |
| Y | 2 | 2 | 6 | 4 |
| Min requirements | 60 | 84 | 72 | |

The Cost function is given as

$$Cost = f(X, Y) = aX + bY$$

Develop a mathematical problem together with its constraints to help minimize the cost of feeds.

Hence solve it to find the minimum cost.

(5 Marks)

d) Find the equation of the line through the point (3, 5) that cuts off the least area from the first quadrant.

(4 Marks)

e) Solve for

$$x^4 - 16x^3 + 86x^2 - 176x - 105 = 0 \text{ Given that two of the roots are 1 and 7}$$

(4 Marks)

f) Fit a first-degree curve from the following data

(6 Marks)

| | | | | | | |
|---|----|----|----|----|----|----|
| X | 1 | 2 | 3 | 4 | 5 | 6 |
| Y | 49 | 54 | 60 | 73 | 80 | 86 |

- g) Solve the IVP $\frac{dy}{dx} = y^2(1 + x^2)$, if $y(0) = 1$ (4 Marks)

QUESTION TWO: (20 MARKS)

- a) A rancher is waxing two types of food, branded X and Y for his Cattle. If each Serving is required to have 60 grams of protein and 30 grams of fat, whereas Brand X has 15 grams of proteins and 10 gram of fat and costs 80 shillings, per unit, and brand Y contain 20 grams of proteins and 5 grams of fat, and costs 50 shillings per unit. How much of each type should be used to minimize the cost to the rancher? (9 Marks)
- b) Find the quotient and remainder when $x^5 - 3x^4 + x^3 - 8x - 135$ is divided by $x - 4$ (5 Marks)
- c) A farmer has 2400 feet of fencing materials and he wants to fence off a rectangular field that borders a straight river banks. He need no fencing along the river. What should be the dimensions of the field that should enable him fence the largest area? (6 Marks)

QUESTION THREE: (20 MARKS)

- a) A right circular cylinder is inscribed in a sphere of radius r . Find the largest possible volume of such a cylinder. (7 Marks)
- b) Solve for $x^4 + 2x^3 - 21x^2 - 22x + 40 = 0$ if the roots are in Arithmetic Progression (6 Marks)
- c) Using the given data, fit an exponential curve $Y = ab^x$ (7 Marks)

| | | | | | |
|---|-----|-------|-------|-------|-------|
| X | 2 | 3 | 4 | 5 | 6 |
| Y | 144 | 172.8 | 207.4 | 248.8 | 298.5 |

QUESTION FOUR: (20 MARKS)

- a) A company produces two types of boats, boat A and boat B. Their available resources are: Aluminium, Machine time, and labour (limited).

The details is as listed in the table below

| BOAT | Aluminium (lb) | Machine time (mins) | Labour (hour) | Profit (\$) |
|------------------------|----------------|---------------------|---------------|-------------|
| A | 50 | 6 | 3 | 50 |
| B | 30 | 5 | 5 | 60 |
| Max usage/availability | 2000 | 300 | 200 | |

As a manager, how many boats of each type should the company produce with the limited resources to maximize profit? (8 Marks)

- b) Find the point on the parabola $y^2 = 2x$ that is closest to the point (1, 4). (7 Marks)
- c) Solve the IVP $y'' - 2y' - y = 0$ given $y(0) = 2$ and $y'(0) = 7$ (5 Marks)

QUESTION FIVE: (20 MARKS)

- a) Find the dual of the following primal

Maximize $Z = 3x_1 + 5x_2 + 7x_3$

Subject to $\begin{cases} x_1 + x_2 + 3x_3 \leq 10 \\ 4x_1 - x_2 + 2x_3 \geq 8 \\ x_1, x_2 \geq 0, x_3 \text{ unrestricted} \end{cases}$ (7 marks)

- b) Find the area of the largest rectangle that can be inscribed into a semi-circle of radius r . (5 marks)
- c) Fit a second-degree parabolic curve to the following data and estimate the production in 2025 (8 marks)

| Year | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2022 | 2024 |
|------------|------|------|------|------|------|------|------|------|
| Production | 12 | 14 | 26 | 42 | 40 | 50 | 52 | 53 |